REMARKS

The foregoing amendments are made to correct minor translational errors and to meet United States requirements as to form. No new matter is added.

Respectfully submitted,

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PATENT
Attorney Docket No. 401312

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YASUDA et al.

Application No.:	Unassigned	Art Unit:	Unassigned
Filed:	July 25, 2001	Examiner:	Unassigned
For:	SENSOR ELEMENT AND METHOD OF FABRICATING THEREOF		

SPECIFICATION, CLAIMS AND ABSTRACT AS PRELIMINARILY AMENDED

Amendment to the paragraph beginning at page 1, line 5:

The present invention relates to a sensor element, particularly to a sensor such as a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor, or an image sensor having a constant area ~~of~~ sensor face.

Amendment to the paragraph beginning at page 1, line 11:

Conventionally, ~~there are used~~ an acceleration sensor, a yaw rate sensor, a pressure sensor, an air flow sensor, and a magnetoresistance sensor are used as sensor elements for controlling running of a vehicle. Among them, each of the acceleration sensor, the yaw rate sensor ~~or~~, and the pressure sensor ~~each is provided with~~ includes a flat pivotally moving electrode (sensing portion) ~~in correspondence with~~ responding to impact or acceleration, and ~~is constituted to be capable of~~ detecting a change in electric capacitance between the electrode and an opposed electrode fixedly arranged ~~to be~~ proximate ~~thereto for detecting a change in impact or acceleration based on~~ the ~~change in the electric capacitance~~ moving electrode. Further, ~~there are used~~ various metal materials are used for the planar electrode constituting the sensing portion, for example, as

described in Japanese Patent Laid-Open No. ~~183145/1993~~ Hei. 5-183145, Japanese Patent Laid-Open No. ~~283712/1993~~ Hei. 5-283712, or Japanese Patent Laid-Open No. ~~194382/1994~~ Hei. 6-194382, a surface thereof is covered and protected by a silicon nitride film or a silicon oxide film, and these inorganic thin films are formed by ~~a~~ sputtering ~~process, a~~ CVD ~~process~~, or ~~a~~ another vapor deposition process.

After the paragraph beginning at page 4, line 6, insert as a heading:

Summary of the Invention

Amendment to the paragraph beginning at page 6, line 16:

~~Fig. 1 illustrates~~Figs. 1A-1G are sectional views for explaining an example of a structure of a magnetoresistance sensor according to the invention and a method of fabricating thereof.

Amendment to the paragraph beginning at page 6, line 19:

~~Fig. 2 illustrates~~Figs. 2A-2D are sectional views for explaining ~~other~~ another example of a structure of a magnetoresistance sensor according to the invention and a method of fabricating thereof.

Amendment to the paragraph beginning at page 6, line 22:

~~Fig. 3 illustrates~~Figs. 3A and 3B are views for explaining a structure of an air flow sensor of Embodiment 1 according to the invention in which Fig. 3~~(a)~~A is a plane view and Fig. 3~~(b)~~B is a sectional -25 view taken along a line ~~A-A~~ IIIB-IIIB of Fig. 3A..

Amendment to the paragraph beginning at page 7, line 1:

~~Fig. 4 illustrates~~Figs. 4A and 4B are views for explaining a structure of an acceleration sensor of Embodiment 3 according to the invention in which Fig. 4~~(a)~~A is a plane view and Fig. 4~~(b)~~B is a sectional view taken along a line ~~B-B~~ IVB-IVB of Fig. 4A.

Amendment to the paragraph beginning at page 12, line 2:

Fig. 1~~(a)~~A through Fig. 1~~(g)~~G are sectional views for explaining an example of a method of fabricating the magnetoresistance sensor according to the invention. First, above the sensor main body 1, there is coated varnish prepared by dissolving silicone polymer shown by the above-described general formula (1) and/or general formula (2) in a solvent of alcoholic species, ketone species, ether species, halogen species, ester species, benzene species, alkoxybenzene species, or cyclic ~~keton~~ ketone species by a film thickness of 10 nm through 50 μm, a heat treatment is carried out at 100°C through 250°C above a hot plate, and the silicone resin film 2 is formed above the sensor main body 1 (Fig. 1~~(a)~~A).

Amendment to the paragraph beginning at page 12, line 14:

Next, there is ~~coated~~ applied an i-line positive resist 3 having a film thickness of 100 nm through 20 pm on the surface of the silicone resin film 2 (Fig. 1~~(b)~~B), ultraviolet ~~ray~~ light (i-line) is irradiated ~~from thereabove by using~~ through a mask 4 having a contact hole pattern for exposing the bonding pad le or dicing lines (not illustrated) of the sensor main body 1, and the i-line positive resist 3 of the contact hole portion is exposed (Fig. 1~~(c)~~C).

Amendment to the paragraph beginning at page 12, line 22:

Next, ~~a~~ developing processing is carried out after carrying out a baking operation after exposure to thereby provide a pattern of the i-line positive resist 3 having a desired pattern (Fig. 1~~(d)~~D).

Amendment to the paragraph beginning at page 13, line 1:

With the pattern of the i-line positive resist 3 as a mask, contact holes are provided by developing the silicone resin film 2. The developing processing is carried out by carrying out dipping development or spinning development by a developer exclusive for the silicone resin film and thereafter cleaning by a rinse solution exclusive for the silicone resin film (Fig. 1~~(e)~~E).

Amendment to the paragraph beginning at page 13, line 8:

Next, after removing the passivation film 1f by a dry etching process (Fig. 1~~(f)~~F), the i-line positive resist 3 above the silicone resin film 2 is removed in a wet state or removed in a dry state by using a reactive ion etching apparatus, an ion beam etching apparatus, or an ashing apparatus, and by using an oven or a hot plate, postbaking is carried out at 200°C through 450°C to thereby cure the silicone resin film 2. Thereby, there is provided the ~~magenetoresistance~~ magnetoresistance sensor covered with the silicone resin film 2, a predetermined portion of which is opened (Fig. 1~~(g)~~G).

Amendment to the paragraph beginning at page 18, line 12:

Fig. 2~~(d)~~D is a sectional view explaining ~~other~~ another example of a magnetoresistance sensor according to the invention. Although the constitution of the sensor main body 1 is the same as that of Fig. 1G, above the sensor main body 1, there is formed a silicone resin film 13 which is photocured to cover at least the sensing portion.

Amendment to the paragraph beginning at page 18, line 22:

Figs. 2~~(a)~~A through 2~~(d)~~D are sectional views for explaining ~~other~~ another example of a method of fabricating a magnetoresistance sensor according to the invention. The method of fabricating the magnetoresistance sensor differs from the above-described method in that there is used a compound prepared by dissolving a polymer having a photocrosslinking ~~performance~~ characteristic in a solvent and adding a photocrosslinking agent or a photopolymerization agent thereto. The silicone resin film is cured by irradiating and exposing ~~from above by using~~ through a mask 5 having a desired pattern, removing the silicone resin film at a portion which is not irradiated with light by ~~a~~ developing ~~processing~~, and ~~carrying out~~ postbaking at 100°C through 250°C (Figs. 2~~(b)~~B and ~~2(c)~~C). When the passivation film 1f is removed by the dry etching process, there is provided the magnetoresistance sensor covered with the silicone resin film 13 which is cured optically and a predetermined portion of which is opened (Fig. 2~~(d)~~D).

Amendment to the paragraph beginning at page 20, line 10:

~~Fig. 3 illustrates~~Figs. 3A and 3B illustrate views for explaining a structure of an air flow sensor of Embodiment 1 according to the invention in which Fig. 3~~(a)~~A is a ~~plane~~ plan view and Fig. 3~~(b)~~B is a sectional view taken along a line ~~A-A~~ IIIB-IIIB of Fig. 3A.

Amendment to the paragraph beginning at page 24, line 5:

Fig. ~~2 (g)~~ 1G is a sectional view for explaining a structure of a magnetoresistance sensor of Embodiment 2 according to the invention. The passivation film 1f of the sensor main body 1 is a silicon nitride film having a film thickness of about 800 nm formed by a sputtering apparatus and the silicone resin film 2 was formed on the surface of the passivation film 1f by the following method.

Amendment to the paragraph beginning at page 25, line 18:

~~Fig. 4 illustrates~~Figs. 4A and 4B are views for explaining a structure of an acceleration sensor of Embodiment 3 according to the invention in which Fig. 4~~(a)~~A is a ~~plane~~ plan view and Fig. 4~~(b)~~B is a sectional view taken along a line ~~B-B~~ IVB-IVB of Fig. 4A.

Amendment to the paragraph beginning at page 28, line 22:

When operation of the acceleration sensor covered with the silicone resin film 45 was confirmed, in accordance with acceleration, the sensing portion 43 was displaced in a direction in which the distance between the sensing portion 43 and the opposed electrode 44 is changed (arrow ~~mark~~ direction of Fig. 4~~(a)~~A). The change in the interval between the side face of the sensing portion 43 and the side face of the opposed electrode 44 was detected as a change in the ~~electric~~ capacitance and it was verified that there was provided a sensitivity of a sufficiently practical level.

Amendments to the existing claims:

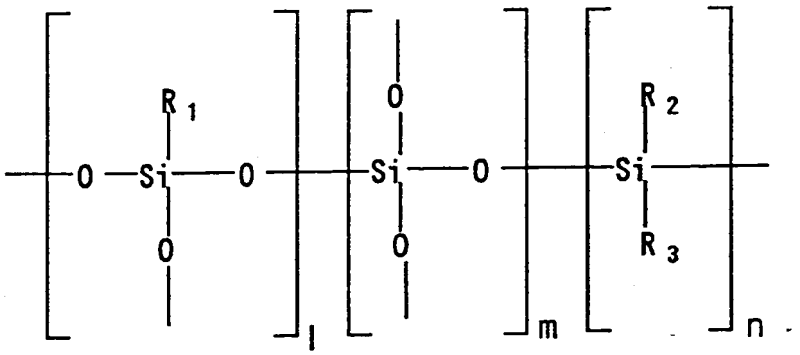
1. (Amended) A sensor element comprising:

a sensor substrate; and

a flat sensing portion supported by the sensor substrate; wherein the surface of the flat sensing portion is covered with a silicone resin film.

2. (Amended) The sensor element according to Claim 1~~,~~ wherein the silicone resin film is a film of a cured silicone polymer.

3. (Amended) The sensor element according to Claim 2, wherein the silicone polymer is represented by the following general formula (1)~~:~~



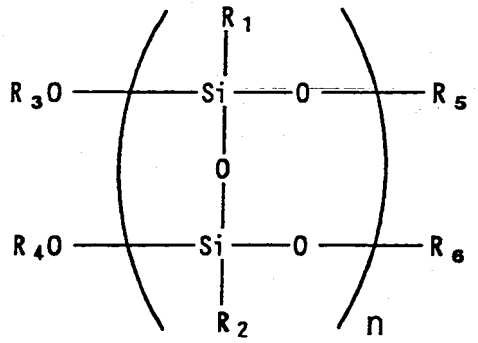
wherein

R1, R2, and R3, which may be the same or different, ~~each is~~ and are selected from the group consisting of an aryl ~~group~~, hydrogen ~~atom~~, an aliphatic alkyl ~~group~~, a hydroxyl ~~group~~, a trialkylsilyl ~~group or~~, and a functional group having an unsaturated bond~~; and~~,

l, m, and n ~~each is~~ are integers ~~of~~ and at least 0 ~~or more~~;, and

the silicone polymer has a weight average molecular weight of not less than 1000.

4. (Amended) The sensor element according to Claim 2~~:~~ wherein the silicone polymer is represented by the following general formula (2)~~:~~



wherein

R1 and R2, which may be the same or different, ~~each is~~ and are selected from the group consisting of an aryl ~~group~~, hydrogen ~~atom~~, an aliphatic alkyl ~~group or~~, and a functional group having an unsaturated bond ~~Notation~~,

R3, R4, R5, and R6, which may be the same or different, ~~each is~~ and are selected from the group consisting of hydrogen ~~atom~~, an aryl ~~group~~, an aliphatic alkyl ~~group~~, a trialkylsilyl ~~group or~~, and a functional group having an unsaturated bond~~;~~,

n is an integers~~;~~, and

the silicone polymer has a weight average molecular weight of not less than 1000.

5. (Amended) The sensor element according to Claim 3~~;~~ wherein the silicone polymer is a photocuring polymer.

6. (Amended) The sensor element according to Claim 4~~;~~ wherein the silicone polymer is a photocuring polymer.

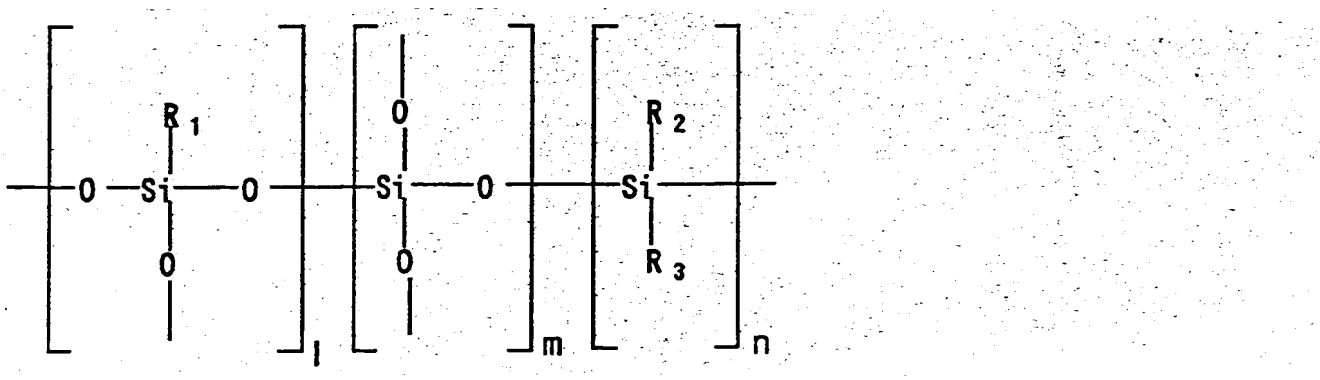
7. (Amended) The sensor element according to Claim 1~~;~~ wherein the sensor element is selected from a magnetoresistance sensor, an air flow sensor, an acceleration sensor, a pressure sensor, a yaw rate sensor, and an image sensor.

8. (Amended) A method of fabricating a sensor element~~;~~ comprising

~~a step of~~ coating ~~a solution of a silicone polymer to~~ a flat sensing portion supported by a sensor substrate with a solution of a silicone polymer; and

~~a step of~~ heating and curing ~~thereof,~~ the solution ~~to coat the sensing portion with~~ form a silicone resin film on the flat sensing portion.

9. (Amended) The method of fabricating a sensor element according to Claim 8~~;~~ wherein the silicone polymer is represented by the following general formula (1)~~;~~



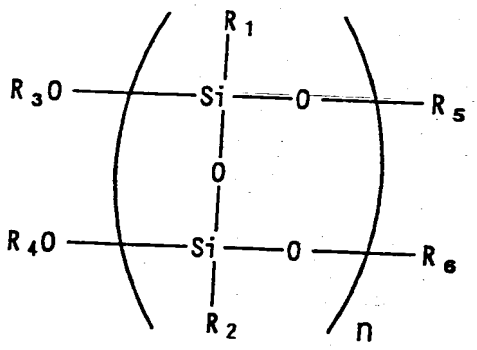
wherein

R1, R2, and R3, which may be the same or different, ~~each is~~ and are selected from the group consisting of an aryl ~~group~~, hydrogen ~~atom~~, an aliphatic alkyl ~~group~~, a hydroxyl ~~group~~, a trialkylsilyl ~~group or~~, and a functional group having an unsaturated bond~~; and~~,

1, m, and n ~~each is~~ are integers ~~of~~ and at least 0 ~~or more~~;, and

the silicone polymer has a weight average molecular weight of not less than 1000.

10. (Amended) The method of fabricating a sensor element according to Claim 8 wherein the silicone polymer is represented by the following general formula (2)~~:~~



wherein

R1 and R2, which may be the same or different, ~~each is~~ and are selected from the group consisting of an aryl ~~group~~, hydrogen ~~atom~~, an aliphatic alkyl ~~group or~~, and a functional group having an unsaturated bond~~. Notation~~,

R3, R4, R5, and R6, which may be the same or different, ~~each is~~ and are selected from the group consisting of hydrogen ~~atom~~, an aryl ~~group~~, an aliphatic alkyl ~~group~~, a trialkylsilyl ~~group or~~, and a functional group having an unsaturated bond~~;~~,

n is an integers~~;~~, and

the silicone polymer has a weight average molecular weight of not less than 1000.

11. (Amended) The method of fabricating a sensor element according to Claim 9~~:~~ ~~wherein~~ including curing the silicone polymer ~~is a photocuring polymer~~ with light.

12. (Amended) The method of fabricating a sensor element according to Claim 10~~, wherein~~ including curing the silicone polymer~~ is a photocuring polymer~~ with light.

13. (Amended) The method of fabricating a sensor element according to Claim 8~~, wherein the step of~~ including heating and curing~~ is carried out~~ the solution at a temperature of from 100°C to 250°C.

Amendment to the abstract:

Abstract

~~The invention provides a~~A sensor element having a sensor substrate and a flat sensor portion supported by the sensor substrate in which the surface of the flat sensing portion is covered with a silicone resin film. The silicone resin film is excellent in step coverage of the flat sensing portion, ~~having~~ applies low stress ~~applied~~ to the sensing portion, can be formed at low temperature, and can prevent the sensing portion from being ~~effected with adverse influence even~~ adversely affected in the fabrication ~~steps~~ process.